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VISION AND AUDITION IN LANGUAGE LEARNING.

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THE PRIMARY PURPOSE WAS TO PRESENT DATA FOR THE TRANSFER OF LEARNING FROM ONE SENSORY MODALITY TO ANOTHER, SPECIFICALLY THE RELATIONSHIP BETWEEN VISION AND AUDITION. THE PARAMETER WAS A RANGE OF NATURAL LANGUAGES INCLUDING SPANISH, JAPANESE, RUSSIAN, TURKISH, AND PERSIAN. THE SECONDARY PURPOSE WAS TO SUGGEST SOME THEORETICAL CONSTRUCTS WHICH MAY ACCOUNT FOR THE DATA, AND THE THIRD PURPOSE WAS TO EXPLORE CERTAIN SIDE ISSUES SUCH AS PRONUNCIATION SHOCK AND THE VALIDITY OF PREDICTORS FOR PAIRED-ASSOCIATE LEARNING. THERE WAS POSITIVE TRANSFER OF LARGE MAGNITUDE FROM VISION TO AUDITION FOR SPANISH, JAPANESE, TURKISH, OR PERSIAN, BUT A SMALL, NEGATIVE TRANSFER FOR RUSSIAN. THERE WAS POSITIVE TRANSFER FROM AUDITION TO VISION FOR SPANISH, JAPANESE, AND RUSSIAN, BUT TRANSFER WAS NEUTRAL FOR TURKISH AND NEGATIVE FOR PERSIAN. THE MAGNITUDE OF THE POSITIVE TRANSFER WAS USUALLY HIGHER FROM VISION TO AUDITION THAN AUDITION TO VISION. MUCH OF THE TRANSFER DATA SEEMED TO BE ACCOUNTED FOR WITH A PHONETIC FIT HYPOTHESIS AND A CENTRAL MEDIATION HYPOTHESIS OF SENSORY PROCESS. THE FIRST CONCEPT, THAT OF PHONETIC FIT, POSTULATES THAT POSITIVE TRANSFER WILL BE A FUNCTION OF THE CONGRUENT MATCH BETWEEN THE SPOKEN AND WRITTEN LANGUAGE. THE GREATER THE CONGRUENCY, THE HIGHER THE PROBABILITY OF POSITIVE TRANSFER BETWEEN SENSORY CHANNELS. THE SECOND CONCEPT, THE CENTRAL MEDIATION HYPOTHESIS, SUGGESTS THAT THE DIRECTION AND AMOUNT OF TRANSFER ARE FUNCTIONS OF DATA PROCESSING NOT AT THE SENSORY RECEPTOR LEVEL, BUT AT SOME CENTRALIZED LOCATION IN THE BRAIN. (LP)

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PERCEPTUAL AND MOTOR SKILLS

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VISION AND AUDITION IN LANGUAGE LEARNING[1]

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Summary.—The primary purpose was to present data for the transfer of learning from one sensory modality to another, specifically the relationship between vision and audition. The parameter was a range of natural languages including Spanish, Japanese, Russian, Turkish, and Persian. The secondary purpose was to suggest some theoretical constructs which may account for the data, and the third purpose was to explore certain side issues such as pronunciation shock and the validity of predictors for paired-associate learning. There was positive transfer of large magnitude from *vision to audition* for Spanish, Japanese, Turkish, or Persian, but a small, negative transfer for Russian. There was positive transfer from *audition to vision* for Spanish, Japanese, and Russian, but transfer was neutral for Turkish and negative for Persian. The magnitude of the positive transfer was usually higher from vision to audition than audition to vision. Much of the transfer data seemed to be accounted for with a *phonetic fit hypothesis* and a *central mediation hypothesis of sensory process*. The first concept, that of phonetic fit, postulates that positive transfer will be a function of the congruent match between the spoken and written language. The greater the congruency, the higher the probability of positive transfer between sensory channels. The second concept, the central mediation hypothesis, suggests that the direction and amount of transfer is a function of data processing *not* at the sensory receptor level, but at some centralized location in the brain.

Most studies have demonstrated that there is transfer between the learning process which occurs through the sensory channels of vision to audition and the reverse from audition to vision. What remains to be resolved is: (a) What is the amount and direction of transfer for a range of conditions such as different

[1]The research reported herein was supported by grants from the U. S. Department of Health, Education, and Welfare, Office of Education. The Title VII Project Nos. were 578 and 873; the Grant Nos. were 7-04-091 and 7-14-1260-156. Appreciation is expressed to Dr. Joseph Reid Scott, Associate Professor of Modern Languages at San Jose State College, for developing and scoring the Spanish materials. Also a special thanks to Dr. Richard B. Lewis, Head of Audio-Visual Services, for his help in obtaining and improvising the necessary equipment for the experiments. The graduate research assistants were Bradley C. Fallentine and Robert G. Reid.

languages; and (b) What theoretical model can account for the intersensory transfer data?

Review of the Literature

Laboratory studies in which the learning task is restricted to a classic experimental format as the paired-associate task, tend to generate data showing that visual learning is faster than auditory learning (Krawiec, 1946; Dunkel, 1948; Kessman, 1959). An experiment by Pimsleur and Bonkowski (1961) designed to explore intersensory transfer showed positive transfer from vision to audition or from audition to vision when the task was vocabulary learning from paralogs to English (i.e., "polef" means green). However, the sequence of learning from audition to vision was significantly better than the reverse sequence of vision, then audition.

Similar intersensory studies by Gaydos (1956) and Sinba and Sinba (1960) demonstrated positive transfer from vision to kinesthetic learning or from kinesthetic to visual learning. The task in Gaydos' study concerned irregular objects which *S*s either viewed or touched in an attempt to associate the shapes with names. In the Sinba and Sinba experiment, the learning task was a linear T-maze with 10 choice points which was learned by touch to an errorless criterion. The same problem was learned visually with two sets of cards corresponding to each choice point in the T-maze. When *S* turned over a card, either the right or left card had "success" printed on it.

Field studies do not tend to explore intersensory transfer with a design in which *S*s learn through one sensory channel then relearn through a different sensory mode. Usually vision has been contrasted with audition so that one group learns by reading and the other by speaking.

For example, Hamilton and Haden (1950) studied the performance of college students learning Spanish and French when the "visual" groups experienced mostly reading and writing while the "oral" groups had 2 wk. of pronunciation training and further listening training 1½ hr. a week for a year. The results were a moderate gain in speaking fluency for the oral group, but the authors concluded ". . . from the first year's experiment we draw the following conclusions: While increased emphasis on oral-auditory aspects of the language is reflected in the results, the difference in results may be considerably less than is often assumed . . ." (p. 89).

Richards and Appel (1956) studied a group ($N = 14$) given 5 hr. of training in which no written Spanish was presented. *S*s viewed pictures and learned to respond with Spanish utterances. The control group ($N = 14$) replicated the training except that they viewed the pictures together with the printed Spanish orthography. The results were a moderate gain on some criterion measures for the orally trained students.

Sawyer, *et al.* (1962) trained *Ss* in Japanese. The two conditions involved listening to tapes for about 5 hr. either with or without a textbook. The results were not clear-cut but seemed to suggest that the combination of listening to tapes and reading a text produced significantly better articulatory fluency ($p = .05$) than listening to Japanese without the text. The Japanese orthography was Romaji.

Scope of This Paper

The primary purpose of this monograph is to present data for the transfer of learning from one sensory channel to another, specifically the relationship between vision and audition. The parameter of importance here is a range of natural languages including Spanish, Japanese, Russian, Turkish, and Persian. The secondary purpose is to suggest possible theoretical constructs which may account for the data. For example, is transfer across sensory channels a function of the phonetic fit between the spoken and written language? Is transfer a function of peripheral factors at the sensory receptor level or central factors at the level of concept-formation? Is it significant for learning theory that children acquire speaking fluency before written language? Thirdly, some side issues are explored such as pronunciation shock, and the validity of predictors for paired-associate learning.

SPANISH EXP. I

The purpose of Exp. I was to explore intersensory relationships with recognition learning. Recognition learning means that *S* was presented with an item such as this:

WORK

TRAMITAR TRABAJAR

S's task was to make a decision as to which of the two Spanish words meant "work."

Procedure

Subjects.—*Ss* ($N = 40$) were undergraduate students who participated in the study to fulfill a course requirement in general psychology. All *Ss* were screened to eliminate anyone with prior training in Spanish either in school, at home, or by travel. Half of the *Ss* (15 males and 5 females) were randomly assigned as visual *Ss* and the other half (16 males and 4 females) as aural *Ss*.

Sample list.—Each *S* learned a sample list of 4 items which were presented visually in this sequence. For 3 sec., *S* would view a 5- × 8-in. card on which was printed an item such as the example previously given. Then there was a 5-sec. interval in which *S* wrote one of the two Spanish alternates he had seen; and finally *E* responded to *S*'s decision by saying "right" or "wrong." The inter-item interval was approximately 5 sec.

As a control for serial learning effects such as position learning, on each trial the items appeared in random order, and whether a member of the Spanish response pair was on the right or left was also randomized on each trial.

When the criterion of learning was achieved by *S*'s giving a correct response twice in a row to an item, that item was removed from the list. This is the Method of Adjusted Learning (Gillette, 1936).

Predictors.—The *visual predictor* was developed as follows. Each *S* learned the 10 items in List 1 with the exact procedure of the samples. Stimuli were presented visually and *S* was required to write or print his response. This was a measure of each *S*'s visual ability to learn symbolic material.

The *aural predictor* was developed in a similar way. Each *S* learned List 2 with the exact procedure of the samples except that stimuli were presented auditorily and *S* was required to pronounce his response. List 2 learning was preceded by a sample of 4 items in which *S* listened to the stimuli and pronounced his responses. Analogous to the operational meaning of List 1, List 2 was interpreted as a measure of *S*'s aural ability to learn symbolic material.

Vocabulary learning.—*Ss* learned 6 more vocabulary lists (including Lists 3, 4, 5, 6, 7, and 8). The sequence of learning for each list was: (1) learn the vocabulary list through sense modality *X*[2] (translate two sentences[3] presented through sense mode *X*); and (2) relearn the vocabulary list through sense modality *Y* (translate two different sentences through sense mode *Y*).

Stories.—At the climax of learning 92 vocabulary items,[4] *Ss* were asked to translate two stories derived from all of the vocabulary items. The first story was presented visually on a mimeographed sheet and the second story was presented auditorily with the Language Master. The translations of both stories were written. The stories were power tests in which *S* was permitted to read or listen to a story as often as he pleased in a 25-min. time limit.

Retention measures.—After translating the stories, each *S* was given a measure of recall and then a measure of recognition for each of the vocabulary items learned.

A schematic diagram of the design is presented in Fig. 1.

Materials

Apparatus and materials.—The vocabulary items were equated by selecting English stimulus words from words labeled AA in the Thorndike-Lorge frequency count (1952). The English words were not only equated on the Thorndike-Lorge count but also on a list of the most frequently spoken words as published in a monograph by Johnson (1944). Each vocabulary list contained the

[2]Sense modality *X* was vision for the visual *Ss* and audition for the aural *Ss*. Sense modality *Y* was audition for visual *Ss* and vision for aural *Ss*.
[3]The sentences were derived from the vocabulary list just learned. The sentence translations were taken as a measure of transfer from the elements, the vocabulary items, to patterned material.
[4]Eight lists of 10 items each, and 3 sample lists of 4 items each.

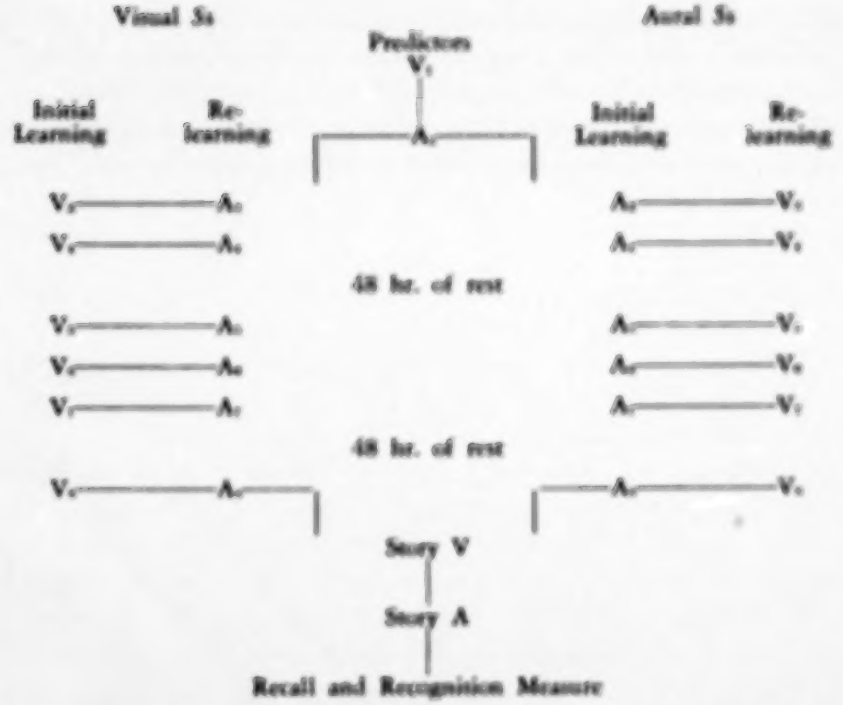

FIG. 1. Schematic diagram of the experimental design for Spanish I [*Key*: A and V refer to auditory or visual learning; the subscript indicates the list learned, as for example, V_3 means that List 3 was learned visually.]

following parts of speech: 1 noun, 2 pronouns, 3 verbs, 1 adjective, 1 adverb, 1 preposition, and 1 conjunction.

Each vocabulary item was printed on a 5- × 8-in. card with a Wricoprint Lettering Set. The letters were ½ in. in size. The Guide No. was VC 1-2P and the pen code was No. 3. Each sentence was printed with Guide No. VC 3-8P, with pen code No. 3. The letters in the sentences were ⅜ in. high.

The vocabulary items and the sentences were visually presented with a Kardex. The Kardex is a commercially available type of office equipment which offered these unique advantages: (a) random access to any item which means that one may have rigorous prerandomization of items on all trials and yet at the same time have a precise record of the performance of each *S* on any item for any given trial, and (b) the random access characteristic permitted items to be eliminated as they were learned. These advantages are not possible with some of the traditional methods of visual presentation such as memory drum, card shuffling, film, slides, or tachistoscope.

The auditory presentation of the vocabulary items and sentences was achieved with the Language Master.[5] This machine played each vocabulary item and each

[5]The Language Master is produced by the Bell and Howell Co., 7100 McCormick Road, Chicago 45, Illinois.

sentence which the language consultant recorded on a strip of iron oxide across the bottom of a card. The Language Master permitted random access to the auditory materials, which is not possible with the tape recorder. This means, for example, that any vocabulary item from the set could be selected immediately without the usual tape recorder problem of loosing items by winding a tape forward or backward.

Results

Vocabulary learning.—Language learning in vocabulary acquisition was measured in errors. Table 1 shows that in the acquisition of Lists 3, 4, 5, 6, and 7 there was significant positive transfer of learning between the sensory channels of (a) vision to audition or (b) audition to vision. The *t* tests were significant beyond the .005 level of confidence.

The technique of analysis was a *criss-cross* strategy in which the first learning of the lists by visual *Ss* was compared with the second learning of the lists by aural *Ss*. In this fashion visual learning was contrasted for visual vs aural *Ss*. Another way of expressing this would be that the initial learning of visual *Ss* was the control for the relearning by vision of the aural *Ss*. The independent variable would be the transfer effect of audition upon vision. If audition produced positive transfer to vision, then errors in visual relearning by aural *Ss* should be significantly less than initial visual learning of visual *Ss*. This was supported with a t of 5.14 ($p < .005$ for 38 df).

The risk in the *criss-cross* technique of analysis is that relearning may be significantly better than initial learning as a function of warm-up and learning-to-learn. *This risk is maximum if a study is based on only one list of items which is learned and relearned*, but the risk tends to be reduced to minimum as the number of lists is increased. In this study, for example, the use of eight lists in succession, theoretically tended to distribute warm-up and learning-to-learn between both conditions of initial learning and relearning.

The *criss-cross* analysis was also applied to evaluate the effect of vision upon audition. If vision produced positive transfer to audition, then errors in auditory relearning by visual *Ss* should be significantly less than initial auditory learning by aural *Ss*. This was supported with a t of 6.68 ($p < .0005$ for 38 df).

Since the distributions of error in relearning were skewed, the application of t tests becomes controversial. Therefore, a non-parametric test of significance, the median test, was also applied. The results, as seen in Table 1, were essentially the same as the findings reported for the t tests. That is, a significant positive transfer of learning from either vision to audition ($p = .001$) or audition to vision ($p = .02$).

In the results just reported, there was one uncontrolled factor. Although the time of exposure was identical for visual and auditory materials, the pattern

TABLE 1

SPANISH 1: ACQUISITION TASKS IN LEARNING

Transfer from Vision to Audition	Initial Auditory Learning by Aural Is			Auditory Relearning by Visual Is			% saving for		t	χ^2
	N	Mdn	SD	N	Mdn	SD	Is	Mdns		
Lists 3, 4, 5, 6, 7	34.40	34.50	16.48	8.00	5.00	10.10	77	86	6.68*	25.68*
List 8	6.90	6.00	3.38	1.35	1.00	2.13	80	83	6.26*	25.68*
Transfer from Audition to Vision	**Initial Visual Learning by Visual Is**			**Visual Relearning by Aural Is**						
	N	Mdn	SD	N	Mdn	SD				
Lists 3, 4, 5, 6, 7	26.75	27.00	12.10	14.50	11.50	12.52	46	57	3.16*	6.60†
List 8	6.05	6.00	2.45	3.00	3.00	2.00	50	50	4.50*	8.12‡

*$p < .001$. †$p = .02$. ‡$p = .01$.

of presentation was different. For example, the visual items printed on a card were presented simultaneously while the auditory material was presented sequentially. In an attempt to evaluate this factor, the visual presentation of List 8 was given sequentially.[6] The results, again referring to Table 1, were in harmony with the previous findings. Both the *t* tests and median tests suggested a significant positive transfer of learning from either vision to audition or audition to vision.

Sensory sequence effects.—The finding of positive transfer from vision to audition or audition to vision does not necessarily suggest that the sequence of learning by vision then audition is about the same as learning first by audition and then by vision. In an effort to evaluate the effect of sensory sequence, an analysis was made of data from acquisition error, retention, and transfer of vocabulary learning to the translation of stories.

First, for each visual *S* the acquisition errors from initial learning by vision and relearning by audition were combined to get a composite error score. Also for each aural *S* the acquisition error was combined for his initial learning by audition and his relearning by vision.

Although the data in Table 1 demonstrated positive transfer from vision to audition or audition to vision, the magnitude of the *t*s and χ^2s suggested that the more powerful sequence may be vision to audition. If so, then the composite error score for the sensory order of vision then audition in learning should be significantly less than the composite errors of the sensory sequence of audition then vision. This expectation was supported ($t = 2.03$, $p < .025$, $df = 38$).

The second analysis for the sensory sequence effect was to compare the retention of visual *S*s vs aural *S*s after the following time delays between learning and the recall tests: 0, 48 hr., and 96 hr. In the recall test, *E* spoke each English stimulus word and *S* was asked to pronounce, then write the appropriate Spanish word. As seen in Table 2, none of the *t*s was significant at the .05 level.

TABLE 2

SPANISH I: RETENTION MEASURED IN CORRECT RECALL

Recall Interval	List	Visual *S*s (N=20)		Aural *S*s (N = 20)		*t*	*p*
		M	*SD*	M	*SD*		
0 hr.	8	2.10	1.97	2.15	1.92	0.00	NS
48 hr.	5, 6, 7	9.80	5.40	8.60	5.16	.71	NS
96 hr.	3, 4	6.05	2.68	6.95	3.66	.88	NS

[6]The visual words were stenciled in a horizontal line on a strip of cardboard which was then run on the guide track of a Language Master. The effect of the setup was that each word and the sentences in List 8 moved from right to left across *S*'s view, as *S* peered through a 2¼- × 3-in. rectangle, cut in a large square of cardboard used to mask the Language Master.

In addition to a test for recall, retention was also measured with a recognition test. For example, *E* pronounced the English stimulus word, then *S* pronounced the Spanish, wrote the Spanish, and then tried to identify the correct Spanish term from two possibilities presented to him. The decision between the two Spanish words was the recognition measure. The findings in Table 3

TABLE 3
SPANISH I: RETENTION MEASURED IN CORRECT RECOGNITION

Recognition Test Presentation	List	Visual *Ss* ($N=20$)		Aural *Ss* ($N=20$)		t	p
		M	SD	M	SD		
Auditory	4, 6, 8	26.00	3.58	24.90	2.78	1.08	NS
Visual	3, 5, 7	28.15	2.08	24.60	2.64	4.70	.0005

were: (a) for auditory recognition of the vocabulary items in Lists 4, 6, and 8, there were no significant differences between visual and aural *Ss*, but (b) for the vocabulary items in Lists 3, 5, and 7, which were presented for visual recognition, the visual *Ss* recognized significantly more ($t = 4.70$, $df = 38$, $p < .0005$).

The third analysis to evaluate the sensory sequence was to compare the performance of visual *Ss* vs aural *Ss* in translating two stories, one of which they read and the other they heard.

These stories were scored in two different ways: (1) Method A, in which each story was sorted into one of three piles classified as low, medium, or high in quality; and (2) Method B, in which each story was analyzed for errors of omission, tense, grammar, mistranslation, and word order. The reliability of this method using a score-rescore procedure was .938.

As a control, each story was scored blindly without knowledge as to whether *S* was visual or aural, and each story was typed on a 3- × 5-in. card which was used for the scoring operations. None of the *t*s from either method of scoring were significant at the .05 level.

Homogeneity of Ss.—Although *Ss* were randomly classified as visual or aural *Ss*, language ability was measured with the predictors. The findings indicated homogeneity of language ability since there were no significant differences between visual and aural *Ss* in acquisition error for either List 1, which was learned visually or List 2, which was learned by listening.

If the assumption is made that prior language learning by *Ss* will be expressed in the learning performance with the work-sample lists, then the factor of experience with other languages was not significantly different between visual and aural *Ss*.

Validity of the predictors.—Generally, the validity coefficients in Table 4

TABLE 4

SPANISH I: VALIDITY COEFFICIENTS FOR THE PREDICTORS

Criterion Measures	Predictors: 20 Visual *Ss*				Predictors: 20 Aural *Ss*			
	List 1	List 2	List 1 + 2	Guessing No. Errors	List 1	List 2	List 1 + 2	Guessing No. Errors
Vocabulary Learning (Lists 2, 3, 4, 5, 6, 7, 8)								
Initial	.30	.23	.30	.82‡	.47*	.86‡	.83‡	.78‡
Relearning	.45*	.58‡	.61‡	.54†	.55†	.84‡	.84‡	.68‡
Sentences (After Initial Learning)								
No. Words Correct	−.65‡	−.32	−.54†	−.51*	−.71‡	−.58‡	−.70‡	−.47*
No. Meanings	−.55†	−.38*	−.59‡	−.38*	−.64‡	−.40*	−.53†	−.42*
Recall (Lists 3, 5, 7)	−.32	−.13	−.16	−.70‡	−.68‡	−.60‡	−.71‡	−.54†
Recognition (Lists 3, 5, 7)	−.36	−.04	−.12	−.61‡	−.34	−.68‡	−.75‡	−.56‡
Story A (Visual)	.29	.06	.18	.82‡	.55†	.63‡	.71‡	.73‡
Story B (Aural)	.53†	.23	.41*	.68‡	.46*	.61‡	.66‡	.59‡

Note.—For 18 *df*, $r = .38$ at p .05*, $r = .52$ at p .01†, $r = .56$ at p .005‡.

were higher for aural *Ss*. A possible explanation may be that the greater difficulty of oral learning as expressed in higher performance variance produced an expanded range for criterion scores of the aural *Ss*, resulting in higher correlations.

The guessing measure.—No training trials were given *Ss*. On the first exposure to the vocabulary items, *Ss* were asked to make a selection by guessing if they did not know which of the two Spanish words was correct. The first trial on all vocabulary items was defined as the guessing score, which was recorded in errors.

Again referring to Table 4, the guessing score was highly correlated with all measures of language learning including (a) vocabulary acquisition, (b) syntactic comprehension, (c) the recall retention measure, and (d) the recognition retention measure. Most of the correlations between guessing and language learning were between .50 and .80, all significant well beyond the .01 level. All correlations reported here and elsewhere in this paper were Pearson product-moment correlations.

Spanish Exp. II

Spanish I demonstrated large, positive transfer from vision to audition or audition to vision when the learning was the recognition-type in which *S* selected the correct Spanish alternate from two possible responses. In Spanish II, transfer was studied when the task was paired-associate, with a picture (i.e., a boat) as the stimulus and the Spanish word (i.e., *barco*) as the response. The use of pictures was an attempt to eliminate English as the mediating process.

Procedure

Subjects.—*Ss* ($N = 40$) were recruited from classes required of all freshmen students at San Jose State and the participants were paid for their services. The logic of selecting only freshmen students was to increase the range of language aptitude within the sample. These same *Ss* were also used in Exp. III. Whether one was a visual or aural *S* was determined by a table of random numbers with 10 men and 10 women placed into each treatment group.

Sample lists.—The first exposure of an item was a training trial in which visual *Ss* viewed a picture for 1 sec. followed by exposure of a Spanish word for 1 sec. The inter-item interval was about 3 sec. On each trial after the first, the visual *S* saw the picture for 1 sec., then had 5 sec. to write the Spanish term, and finally he viewed the correct Spanish word for 1 sec.

Items, given randomly on each trial, were eliminated from the list as *S* responded correctly twice in a row. Then, *S* relearned the list by audition. The procedure was to view the picture and pronounce the Spanish, then listen to the correct Spanish pronunciation.

Aural *Ss* reversed the order by first learning through vision, then relearning by audition.

The first *picture vocabulary* was in *List 9*. Visual *Ss* learned vocabulary List 9 visually, then relearned the same items auditorily. The aural *Ss* reversed the sequence by learning aurally and relearning visually.

On *List 10*, a *picture vocabulary*, visual *Ss* learned vocabulary List 10 auditorily, then relearned the same items visually. The aural *Ss* reversed the sequence by learning visually and relearning aurally.

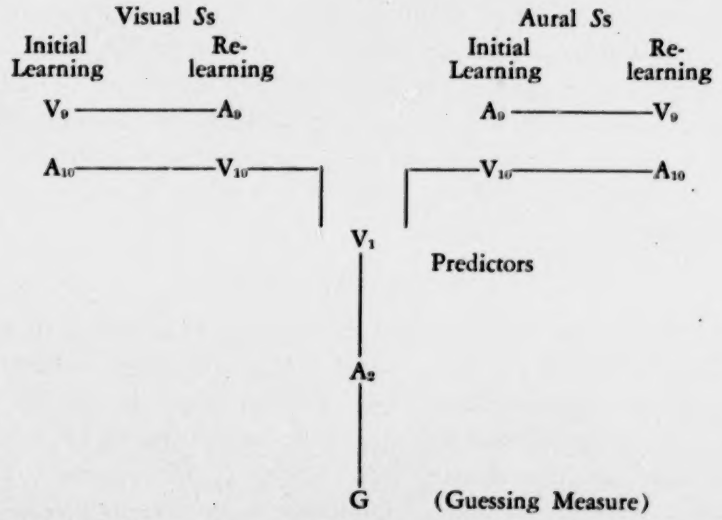

FIG. 2. Schematic diagram of the design for Spanish II [*Key:* see Fig. 1]

Predictor measures.—All *Ss* learned the visual and aural predictor measures, Lists 1 and 2, which were used in Exp. I. The only difference was that the administration was paired-associate as described in the section under Sample List.

If the predictor measures, which had English words as stimuli, had *preceded* the picture vocabulary learning, there is the possibility that *Ss* might have learned that one should use English to mediate between the concept and the foreign symbol. Since the aim in the picture vocabulary learning was to eliminate dependency on English as a mediator between a concept and the foreign language, the risk of mediation was reduced by giving the predictors *after* the picture vocabulary learning.

Guessing measure.—Vocabulary items from Exp. I were visually presented to *Ss*. Here is an illustration of a typical item:

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TABLE 5

SPANISH II: ACQUISITION ERROR IN LEARNING

Transfer from Vision to Audition	Initial *Auditory* Learning by Aural *Ss*			*Auditory* Relearning by Visual *Ss*			% Saving for		t	χ^2
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*	*M*	*Mdn*		
List 9	10.00	10.00	7.28	.50	0.00	.88	95	100	5.79*	22.56*
List 10	20.90	21.00	13.27	2.35	1.00	3.67	89	95	6.02*	22.56*
Transfer from Audition to Vision	**Initial *Visual* Learning by Visual *Ss***			***Visual* Relearning by Aural *Ss***						
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*				
List 9	8.00	6.00	7.24	.85	1.00	.87	89	83	4.38*	16.94*
List 10	14.55	9.50	10.97	4.10	3.00	3.17	72	68	4.09*	12.13*

*$p \leq .001$.

S's task was to guess which of the Spanish words was the correct selection. *E* gave no feedback as to the correctness of the response. This guessing measure was based on items from Lists 3, 4, 5, 6, 7, and 8.

Materials and apparatus.—The pictures in the vocabulary items were selected from those nouns listed as AA in the Thorndike-Lorge frequency count. Pictures were drawn in India ink on 5- × 8-in. cards. The Spanish words were printed with a Wricoprint Set, Guide No. VC 1-2P with pen code No. 3.

As in Exp. I, the visual materials were presented with the Kardex and the auditory materials were played through the Language Master.

Results

The scoring of the vocabulary items required a judgment by *E* as to how well *S*'s written or spoken response approximated the ideal response. The reliability of *E*'s scoring decisions was estimated by asking two judges to score independently a sample of responses. This was done by randomly selecting 8 *S*s and taping their spoken responses. The result was that the judges disagreed about 1% of the time for written responses and about 5% for the spoken responses.

Picture vocabulary learning.—Table 5 shows that in the acquisition of List 9 or List 10, there was a significant positive transfer of learning between the sensory channels of (a) vision to audition, or (b) audition to vision. The *t* tests were significant beyond the .001 level of confidence.

Since skewness was extreme, again the median test was applied and the results were in harmony with the *t* tests in that there were positive transfers significant beyond the .001 level.

Sensory sequence effects.—The finding in Exp. I that the sequence of vision then audition produced faster learning than audition followed by vision was upheld only for picture vocabulary List 10 in which $t = 1.78$ ($p < .05$, $df = 33$). The *t* for List 9 was .97 which was not significant at the .05 level. This analysis was based on composite errors, as has been described for Spanish I.

The second analysis for the sensory sequence effect was to compare the retention of visual *S*s vs aural *S*s after a time delay between learning and recall of approximately 1 mo. As seen in Table 6, a *t* of .17 was not significant for

TABLE 6

SPANISH II: RETENTION MEASURED IN CORRECT RECALL OVER 1 MO.

	Visual *S*s		Aural *S*s		*t*	*p*
	M	*SD*	*M*	*SD*		
List 9	4.00	2.80	4.15	2.14	.17	NS
List 10	2.74	1.99	1.56	1.89	1.79	.05

TABLE 7

SPANISH II: VALIDITY COEFFICIENTS FOR THE PREDICTORS

Criterion Measures	Predictors: Visual *Ss*				Predictors: Aural *Ss*			
Picture Vocabulary	List 1	List 2	List 1 + 2	Guessing No. Correct	List 1	List 2	List 1 + 2	Guessing No. Correct
Initial Learning ($N=20$)								
List 9	.65‡	.59‡	.69‡	−.27	.49*	.71‡	.71‡	−.63‡
List 10	.86‡	.62‡	.80‡	−.27	.81‡	.58‡	.76‡	−.61‡
Relearning ($N=20$)								
List 9	.53†	.36	.47*	−.19	.10	.38*	.31	−.13
List 10	.61‡	.65‡	.71‡	−.52†	.44*	.51*	.55†	−.61‡
Recall (Ns = 16 visual *Ss*, 19 aural *Ss*)								
List 9	−.57†	−.22	−.85‡	.35	−.55†	−.75‡	−.76‡	.52*
List 10	−.32	−.68‡	−.64‡	.22	−.47*	−.57†	−.60‡	.40*

*$p = .05$. †$p = .01$. ‡$p = .005$.

List 9, but the t of 1.79 for List 10 was significant at .05 level showing again that the sequence of vision then audition was superior.

Homogeneity of Ss.—Homogeneity of language ability between visual and aural *Ss* was demonstrated with the predictor measures, List 1 and List 2.

Validity of the predictors.—The validity coefficients in Table 7 tended to be high, most of them in the range of .40 to .80. The magnitude of the coefficients tended to increase when Lists 1 and 2 were combined.

The guessing measure yielded high validities only for the performance of aural *Ss*.

Spanish Exp. III

Spanish Exps. I and II have shown that there is significant positive transfer of learning when the sequence is vision then audition, or audition then vision; but a vision-audition order seemed to be more effective. These findings held for recognition learning as when *Ss* observed two possible foreign language responses, then selected the correct alternate, or recall learning in a paired-associate format with pictures for the stimuli and Spanish words as the responses.

The next study, Spanish III, was basically a replication of Spanish I with the exception that learning was by paired-associate rather than recognition. The intent was to determine whether the results of Spanish II, when the stimulus was a picture, would hold for English words as stimuli.

Procedure

Measures.—These were vocabulary learning, recall and recognition. For *vocabulary learning* the first exposure of an item was a training trial in which visual *Ss* viewed an English word for 1 sec. followed by a Spanish word for 1 sec. The inter-item interval was about 3 sec. On each trial after the first, the visual *S* saw the English stimulus for 1 sec., then had 5 sec. to write the Spanish term, and finally he viewed the correct Spanish word for 1 sec.

Items, presented randomly on each trial, were eliminated from the list as *S* responded correctly twice in a row. After learning a list of vocabulary items by vision, the visual *S* was asked to translate two sentences which were derived from the list just acquired. Then *S* relearned the list by audition. Aural *Ss* reversed the order of sensory learning.

As in Spanish I, the sequence was vocabulary learning through one sense modality, then translation of sentences; vocabulary relearning through a different sense modality followed by the translation of a different set of sentences.

After vocabulary Lists 4, 5, 6, 7, and 8 were learned, each *S* was administered the recall and recognition measures.

Materials and apparatus.—These were identical to those described in Spanish I.

Subjects.—*Ss* were the same individuals who participated in Spanish II.

TABLE 8

SPANISH III: ACQUISITION ERROR IN LEARNING

Transfer from Vision to Audition	Initial *Auditory* Learning by Aural *Ss*			*Auditory* Relearning by Visual *Ss*			% saving for		*t*	χ^2
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*	*Ms*	*Mdns*		
Lists 4, 5, 6, 7	58.05	51.00	36.11	10.76	10.00	7.64	82	80	5.29‡	18.84†
List 8	14.47	11.00	9.58	.88	0.00	1.16	94	100	5.80‡	28.42†
Transfer from Audition to Vision	**Initial *Visual* Learning by Visual *Ss***			***Visual* Relearning by Aural *Ss***						
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*				
Lists 4, 5, 6, 7	37.88	35.00	19.57	26.63	23.00	20.37	30	34	1.68*	5.46**
List 8	9.17	7.00	6.84	5.05	4.00	4.67	45	43	2.13**	3.95*

Note.—Visual *Ss*, $N = 17$; Aural *Ss*, $N = 19$.
*$p = .05$. **$p = .02$. †$p = .001$. ‡$p = .0005$.

Attrition reduced the *N* from 40 to 36. Visual *Ss* were reduced to 17 and aural *Ss* were reduced to 19.

Results

Vocabulary learning.—The *t* tests in Table 8 indicated that in the acquisition of Lists 4, 5, 6, and 7, there was significant positive transfer of learning between the sensory modalities of (a) vision to audition ($p = .0005$), and (b) audition to vision ($p = .05$). Since skewness was extreme, the median test was applied and the results were consistent with the *t* tests in that there was significant positive transfer for vision to audition ($p < .001$), and for audition to vision ($p < .02$).

As in Spanish I, an attempt was made to evaluate the sequential input of audition vs the simultaneous input of vision. The visual presentation of List 8 was displayed sequentially as was described in the first study (see Footnote 6). The results in Table 9 were in harmony with those reported for Lists 4, 5, 6, and 7. There was significant positive transfer from vision to audition (t, $p = .0005$; χ^2, $p = .001$), and significant positive transfer from audition to vision (t, $p = .02$; χ^2, $p = .05$).

TABLE 9

SPANISH III: RETENTION MEASURED IN CORRECT RECALL

Recall Interval	List	Visual *Ss* ($N=17$)		Aural *Ss* ($N=19$)		t	p
		M	*SD*	*M*	*SD*		
0 hr.	7, 8	17.00	2.57	16.26	3.70	.68	NS
48 hr.	4, 5, 6	12.41	4.79	12.73	4.31	.20	NS

Sensory sequence effects.—The first analysis based on composite errors suggested that the order of vision-audition was superior to audition-vision ($t = 2.65$, $p < .01$, $df = 34$).

The second analysis for the sensory sequence effect compared the retention of visual *Ss* vs aural *Ss* for time delays between learning and recall of 0 and 48 hr. The results in Table 9 were not significantly different.

Homogeneity of Ss.—Visual and aural *Ss* were homogeneous in visual and aural learning ability as measured by the predictors, vocabulary Lists 1 and 2.

Validity of the predictors.—As in Spanish I, the visual and oral work sample tests, Lists 1 and 2, had higher correlations for aural than visual *Ss*. Almost all the validity coefficients, displayed in Table 10, for aural *Ss* were highly significant ($p < .005$).

For the guessing measure, the results were similar to those for Spanish II in showing higher validity coefficients for aural *Ss* in comparison with visual *Ss*.

TABLE 10

SPANISH III: VALIDITY COEFFICIENTS FOR THE PREDICTORS

Criterion Measures	Predictors: 17 Visual Ss				Predictors: 19 Aural Ss			
	List 1	List 2	List 1 + 2	Guessing No. Correct	List 1	List 2	List 1 + 2	Guessing No. Correct
Initial Vocabulary Learning (All Lists)	.80†	.77†	.90†	−.58*	.79†	.88†	.96†	−.74†
Relearning of Vocabulary (All Lists)	.75†	.52*	.69†	−.59*	.74†	.69†	.80†	−.66†
Sentences, After Initial Learning								
No. Words Correct	.04	.12	.10	.09	−.73†	−.74†	−.83†	.70†
No. Meanings	−.41*	−.18	−.30	.37	−.51**	−.67†	−.69†	.61†
Sentences, After Relearning								
No. Words Correct	−.54*	−.35	−.48*	.49*	−.74†	−.62†	−.75†	.88†
No. Meanings	−.26	−.21	−.26	.25	−.69†	−.61†	−.72†	.70†
Recall	−.28	−.42*	−.42*	−.18	−.79†	−.70†	−.83†	−.72†
Recognition	−.31	−.41*	−.43*	−.57**	−.05	.02	.04	−.06†

Note.—For 15 and 17 *df*, $r = .41$ and .39 at p .05*, $r = .56$ and .53 at p .01**, and $r = .61$ and .58 at p .005†.

JAPANESE EXP. I[7]

Spanish studies I, II, and III demonstrated for a range of conditions that (a) there was significant positive transfer from vision to audition or audition to vision, but (b) the sequence of vision-audition tended to be more effective, at least in learning, than the sequence of audition-vision. These findings may be related to the phonetic fit between the spoken language and the orthography of Spanish. In Spanish, the visual notation tends to have a one-to-one correspondence with the allophones. Since Japanese also has an excellent phonetic fit between sounds and visual notation in *Romaji*, the expectation was that the sensory transfer phenonema of Spanish and Japanese should be similar. This expectation was tested in the next study with Japanese which basically replicated in procedure the design of Spanish III.

Procedure

Subjects.—Forty undergraduate students with no history of prior training or exposure to Japanese were randomly assigned as visual or aural *Ss*. Each group had 10 males and 10 females.

Predictors.—Five predictor measures were administered. The *first* was a standardized measure of language aptitude called the *Modern Language Aptitude Test* (Carroll & Sapon, 1959) and administered in groups of 10 to 15 *Ss*.

The *second* measure was the Gamma form of the *Otis Mental Ability Test* (1953) which was administered to the groups after they completed the Modern Language Aptitude Test.

The *third* predictor was the guessing measure which was included because it yielded high validity coefficients in the Spanish studies. This was administered individually to each *S*. If *S* was assigned as a visual *S*, then he viewed a card on which was printed an English word as "up" and below on the same card were two Japanese terms as in this example, "AGARU" and "AGAKU." *S* made a decision as to which of the Japanese words meant "up," then indicated his decision on an IBM Answer Sheet. No information was given *S* as to the correctness of his choice. The items ($N = 92$) in the guessing measure were based on the English words used in Spanish I.

Those individuals assigned as aural *Ss* *listened* to each guessing item, then marked the decision on an IBM Answer Sheet.

The *fourth* predictor was a measure of each *S*'s visual ability to learn symbolic material. The task was to learn the 10 items in List 1 to a criterion of two perfectly written Japanese responses in a row for each item.

The *fifth* predictor was a measure of each *S*'s aural ability to learn symbolic material. The task was to learn the 10 items of List 2 by listening to each

[7]Dr. Kazumitsu W. Kato, Assistant Professor of Modern Languages at the University of California at Berkeley, prepared the Japanese materials and scored *Ss*' taped utterances. The graduate research assistants were Arthur C. Vicory and John Doolittle.

English stimulus and Japanese response. The exact procedure for the learning of Lists 1 and 2 will be described in the next section.

Vocabulary learning.—The first two exposures of an item were training trials in which visual *Ss* ($N = 20$) viewed an English word for 1 sec. and then a Japanese word for 2 sec. The inter-item interval was about 3 sec. On each trial after the second training trial, the visual *S* saw the English stimulus for 1 sec., then had 7 sec. to write the Japanese, and finally viewed the correct Japanese for 2 sec. The difference in response time for Spanish (5 sec.) and Japanese (7 sec.) is explained by the longer time necessary to write many of the lengthy Japanese words.

Items, presented randomly on each trial, were eliminated from the list as *S* responded correctly twice in succession. The inter-item interval was about 12 sec. When the criterion of two perfect responses was achieved for each item, a retention test was administered. Here *E* uttered each English word in the list and *S* had 15 sec. to write the corresponding Japanese. After the retention test, the visual *S* was asked to translate two sentences which were constructed from the lists just acquired. Then a 5-min. rest after which *S* relearned the list by listening to the stimulus and responding by uttering the Japanese. This relearning by audition was followed by another retention test in which *E* again gave the English word and *S* pronounced the Japanese one. These oral utterances by *S* were taped and later scored by an instructor of Japanese.

The retention test was followed by the translation of two different sentences after hearing each once.

Aural *Ss* ($N = 20$) experienced the same procedure except in reversed order—learning first by listening to the items and pronouncing the Japanese, then relearning by viewing the items and responding with the written Japanese.

The timing of all visual materials—vocabulary items and sentences—was identical with the time necessary for auditory transmission of the words and sentences.

In the individual sessions the sequence of events was as follows: (a) on the first day *S* was given the guessing measure, List 1 which was learned visually, List 2 which was learned aurally, and Lists 4 and 5, each of which was learned by vision then audition, or audition then vision, depending on whether the individual was classified as a visual or aural *S*; then (b) 48 hr. later *S* learned Lists 7 and 8, followed by a retention test for all 60 items learned.

Materials and apparatus.—These were identical to those described in Spanish I.

Results

Vocabulary learning.—The *t* tests in Table 11 suggest that in the acquisition of Lists 4, 5, and 7, there was significant positive transfer of learning be-

TABLE 11

JAPANESE I: ACQUISITION ERROR IN LEARNING

Transfer from Vision to Audition	Initial *Auditory* Learning by Aural *Ss*			*Auditory* Relearning by Visual *Ss*			% saving for		*t*	χ^2
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*	*M*s	*Mdn*s		
Lists 4, 5, 7	127.60	89.00	72.40	20.10	14.50	22.74	84	84	6.33‡	32.40‡
List 8	25.30	21.00	15.80	3.90	1.00	7.03	85	95	5.53‡	23.02‡
Transfer from Audition to Vision	**Initial *Visual* Learning by Visual *Ss***			***Visual* Relearning by Aural *Ss***						
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*				
Lists 4, 5, 7	58.20	47.00	34.40	43.40	25.50	39.17	25	46	1.27*	2.51**
List 8	20.90	18.00	10.47	10.50	7.50	9.68	50	58	3.26‡	8.12†

*$p = .15$. **$p = .20$. †$p = .01$. ‡$p \leqq .001$.

tween the sensory modalities of vision to audition ($p = .0005$), but *not* between audition and vision ($p = .15$). Since skewness was extreme, the median test was applied, showing results consistent with the t tests. There was significant positive transfer from vision to audition ($p < .001$), but the transfer was *not* significant from audition to vision ($p > .05$).

These findings were independently supported by data from Fallentine (1961) and Clock (1962) who used a 10-item list of English to Japanese paired-associate items with the Method of Adjusted Learning. They found, with the median test, a significant positive transfer of learning from vision to audition ($\chi^2 = 20$, $p < .001$, 1 df). However, there was no significant transfer from audition to vision ($\chi^2 = .80$, $p > .05$).

As in the studies with Spanish, an attempt was made to evaluate the factor of differential input for vision vs audition. That is, visual input tends to be simultaneous relative to the sequential input of audition. The visual presentation of List 8 was displayed sequentially as was described in Footnote 6.

The results in Table 11 suggest that when input was sequential for vision as well as audition, there was significant positive transfer of learning for vision to audition or from audition to vision.

Sensory sequence effects.—The first analysis was based on composite errors in which the errors in initial learning and relearning were summed for each *S*. For example, if a visual *S* had 10 errors in initial learning by vision and 5 errors in relearning by audition, his composite error score would be 15.

The rationale behind composite error scores was this. If the sensory order of visual learning followed by aural relearning is superior to the reversed order of aural learning followed by visual relearning, then the composite error scores

TABLE 12

JAPANESE I: RETENTION MEASURED IN CORRECT RECALL

	Visual *Ss* ($N = 20$)		Aural *Ss* ($N = 20$)		t	p
	M	SD	M	SD		
Retention Test Immediately After Learning						
Lists 4, 5, 7						
Phonemic Accuracy	25.59	5.37	19.29	6.28	3.14	.005
Intonation	18.00	5.51	12.71	6.90	2.47	.01
List 8						
Phonemic Accuracy	8.88	1.62	7.50	2.14	2.18	.025
Intonation	6.65	2.15	6.05	2.40	.79	NS
Retention After 48 Hr.						
List 4						
Phonemic Accuracy	1.65	1.96	1.54	1.66	.14	NS
Intonation	.83	1.62	.78	1.01	.10	NS

TABLE 13

JAPANESE I: VALIDITY COEFFICIENTS FOR THE VISUAL AND ORAL TESTS

Criterion Measures	Visual *Ss* ($N = 20$)			Aural *Ss* ($N = 20$)		
	Visual Test (List 1)	Oral Test (List 2)	Composite (Lists 1 + 2)	Visual Test (List 1)	Oral Test (List 2)	Composite (Lists 1 + 2)
Acquisition Error in Initial Learning for Lists 4, 5, 7, and 8	.84†	.71†	.87†	.63†	.95†	.86†
Immediate Recall for Lists 4, 5, 7, and 8	−.90†	−.62†	−.85†	−.67†	−.89†	−.85†
48-Hr. Delayed Recall for Lists 4 and 5	−.39*	−.48*	−.49*	−.41*	−.51*	−.50*
Pronounciation for Immediate Recall of Lists 4, 5, 7, and 8						
Phonemic Accuracy	−.61†	−.27	−.48*	−.64†	−.77†	−.81†
Intonation	−.42*	−.28	−.39*	−.51*	−.66†	−.67†
Sentences After Initial Learning						
No. Words Correct	−.67†	−.38*	−.58†	−.73†	−.72†	−.78†
No. Meanings Correct	−.49*	−.40*	−.49*	−.53**	−.53**	−.58†

Note.—For 18 *df*, $r = .38$ at p .05*, $r = .52$ at p .01**, $r = .56$ at p .005†.

of visual *Ss* should be significantly less than those of aural *Ss*. The expectation was confirmed when the mean composite error from Lists 4, 5, and 7 was 78.30 for visual *Ss* and 171 for aural *Ss*. The difference between the means yielded a t of 3.42 ($p < .005$).

When a similar analysis with composite scores was run for List 8, a mean composite error of 24.80 for visual *Ss* was obtained and 35.80 for aural *Ss*. The t of 1.68 was significant at the .05 level. Both t tests, for Lists 4, 5, 7, and 8, indicated that the sequence of vision-audition was superior to audition-vision for the acquisition of Japanese.

The second analysis in Table 12 was for the quality of pronunciation during retention immediately after learning. The findings were significant and continued to support the inference that the sequence of vision-audition for Japanese was better than audition-vision. However, after 48 hr. the superiority of either sensory sequence was negligible as measured by the quality of pronunciation for List 4.

Homogeneity of Ss.—Although *Ss* were randomly assigned as visual or aural *Ss*, ability factors as measured by the predictor tests, were examined to confirm the homogeneity of *Ss* between groups. The results with median tests showed no significant differences between visual vs aural *Ss* on any of the predictor tests.

Validity of the predictors.—Validity coefficients tended to be highest for the visual and oral tests. There are presented in Table 13. The *Modern Language Aptitude Test* had the next highest set of correlations with the criterion measures as seen in Table 14. Also in Table 14 are displayed the validity coefficients for

TABLE 14

JAPANESE I: VALIDITY COEFFICIENTS FOR MODERN LANGUAGE APTITUDE TEST (MLAT) AND OTIS MENTAL ABILITY TEST

Criterion Measures	Visual *Ss* ($N = 20$)		Aural *Ss* ($N = 20$)	
	MLAT	Otis	MLAT	Otis
Acquisition Error in Initial Learning for Lists 4, 5, 7, and 8	−.73†	−.53**	−.64†	−.60†
Immediate Recall for Lists 4, 5, 7, and 8	.64†	.39*	.65†	.69†
48-Hr. Delayed Recall for Lists 4 and 5	.57†	.42*	.37*	.46*
Pronunciation for Immediate Recall of Lists 4, 5, 7, and 8				
Phonemic Accuracy	.63†	.54**	.73†	.81†
Intonation	.40*	.11	.74†	.74†
Sentences After Initial Learning				
No. Words Correct	.69†	.52**	.67†	.63†
No. Meanings Correct	.74†	.58†	.54**	.38*

Note.—For $df = 18$, $r = .38$ at p .05*, $r = .52$ at p .01**, $r = .56$ at p .005†.

TABLE 15
VALIDITY COEFFICIENTS FOR GUESSING MEASURE IN JAPANESE EXP. I

Criterion Measures	Visual *Ss* ($N = 20$)			Aural *Ss* ($N = 20$)		
	G_1	G_2	G_3	G_1	G_2	G_3
Acquisition Error in Initial Learning for Lists 4, 5, 7, and 8	−.34	−.08	−.27	.19	.09	.07
Immediate Recall for Lists 4, 5, 7, and 8	.38*	.12	.31	−.09	.09	.07
48-Hr. Delayed Recall for Lists 4 and 5	.27	.06	.21	−.04	.20	.29
Pronunciation for Immediate Recall of Lists 4, 5, 7, and 8						
Phonemic Accuracy	.44*	.06	.32	−.19	.10	.04
Intonation	.52**	.12	.40*	−.32	.05	−.04
Sentences After Initial Learning						
No. Words Correct	.08	.20	.15	−.12	.03	.09
No. Meanings Correct	−.03	.07	.01	−.01	−.04	.05

Key.—G_1 = Guessing score for items learned, G_2 = Guessing score for items not learned, $G_3 = G_1 + G_2$.
Note.—For 18 *df*, $r = .38$ at p .05*, $r = .52$ at p .01**.

the *Otis Mental Ability Test.* Finally, the guessing measure in Table 15 yielded almost zero-order correlations for most of the coefficients.

Reliability of the criterion measures.—With one exception, all the reliability coefficients in Table 16 were within an acceptable range of about .70 to .90.

TABLE 16
JAPANESE I: RELIABILITY OF THE CRITERION MEASURES*

	Visual *Ss*	Aural *Ss*
Acquisition (Total Errors)	.921	.946
Immediate Recall	.730	.920
Delayed Recall	.822	.793
Pronunciation		
Phonemic Accuracy	.913	.921
Intonation	.745	.942
Sentences		
No. Words Correct	.755	.893
No. Meanings Correct	.828	.291

*All correlations are Lists 4 and 5 vs 7 and 8 except delayed recall which is List 4 vs List 5. All coefficients have been adjusted with the Spearman-Brown formula for split-halves.

Intercorrelations of the predictors.—These correlations can be examined in Table 17. The predictors were substantially intercorrelated, except for the guessing measures.

TABLE 17

JAPANESE I: INTERCORRELATIONS BETWEEN PREDICTORS FOR VISUAL AND AURAL *Ss* (*Ns* = 20)

Predictors	MLAT	OTIS	G_1	G_2	G_3	VT	OT	C
				Visual *Ss*				
MLAT		.75	.30	−.01	.19	−.60	−.36	−.53
OTIS	.75		.32	.05	.24	−.32	−.08	−.22
G_1	.30	.32		.50	.91	−.37	−.19	−.31
G_2	−.01	.05	.50		.82	−.25	−.04	−.16
G_3	.19	.24	.91	.82		−.37	−.15	−.28
VT	−.60	−.32	−.37	−.25	−.37		.60	.88
OT	−.36	−.08	−.19	−.04	−.15	.59		.90
C	−.53	−.22	−.31	−.16	−.28	.88	.90	
				Aural *Ss*				
MLAT		.79	.19	−.10	−.01	−.58	−.71	−.70
OTIS	.79		−.10	.09	.15	−.52	−.69	−.66
G_1	−.19	−.10		.54	.79	.18	.16	.18
G_2	−.10	.09	.54		.85	−.04	.06	.01
G_3	−.01	.15	.79	.85		−.00	.03	.02
VT	−.58	−.52	.18	−.04	−.45		.70	.92
OT	−.71	−.69	.16	.06	.03	.70		.93
C	−.70	−.66	.18	.01	.02	.92	.93	

Key.—MLAT = Modern Language Aptitude Test, OTIS = Otis Test of Mental Ability, G_1 = Guessing score for items later learned, G_2 = Guessing score for items not learned, G_3 = $G_1 + G_2$, VT = Visual test, OT = Oral test, C = VT + OT.
Note.—For 18 *df*, $r = .38$ at p .05, $r = .52$ at p .01, and $r = .56$ at p .005.

JAPANESE EXP. II

The primary purpose of Japanese II was to explore the phenomenon of "*pronunciation shock*." From classroom observation, foreign language instructors report pronunciation shock as a sudden decrease in the quality of pronunciation when orthography is introduced after students have achieved speaking proficiency during oral training.

The intent in this study was to set up conditions which might produce pronunciation shock in a laboratory setting. If the phenomenon could be reproduced, then theoretically it would be possible to explore some of the parameters and determinants.

Procedure

Subjects.—Undergraduates, 8 males and 8 females, volunteered in response to an incentive of extra-credit in the general psychology course in which they were enrolled. None had a history of training or exposure to Japanese.

Predictors.—Only two predictors, the *Modern Language Aptitude Test* and the *Otis Mental Ability Test*, were administered. The guessing measure was not given because of the low validities in Japanese I; the visual and oral tests were

omitted because of possible contamination with pronunciation training, which will be described next.

Pronunciation training.—The intent was to maximize response learning of the Japanese before *Ss* attempted to associate meaning with the Japanese.

Before *S* heard any English for a set of items, he listened to a Japanese utterance, pronounced the foreign word into a microphone for a taped record, then listened to the Japanese again. This cycle continued for five repetitions, then *S* practiced the next Japanese utterance in the list for five trials.

From the tape of *S*'s spoken Japanese during the pronunciation training, the expert scored each response for the number of phonemes correct and whether or not intonation was acceptable. Also, a measure of *S*'s perception of his own pronunciation was obtained by asking *S* to judge whether his utterance was the same as the native voice or in any way deviant. This decision was recorded by *S* with a plus or minus after each attempt at pronunciation.

When the pronunciation training was completed, *Ss* learned the list in exactly the manner which was described for aural *Ss* in Japanese I. *Ss* learned Lists 4, 5, 7, and 8 first by listening and speaking, then relearned by viewing and writing. However, an additional auditory retention test was given after each list was visually relearned. The purpose of this was to measure an increase or decrease in the quality of pronunciation after *S* was exposed to orthography.

Results

Pronunciation shock.—Contrary to expectation, no pronunciation shock was obtained as is indicated in Table 18. The quality of pronunciation was significantly increased after the *Romaji* orthography of Japanese was introduced.

TABLE 18

JAPANESE II: PRONUNCIATION SHOCK: AURAL *Ss*

	Pronunciation Scores After Oral Learning	Pronunciation Scores After Orthography was Introduced	
	Phonemic Accuracy (No. Perfect Utterances)		
M	28.27	31.41	
s	5.46	6.04	$t = 4.41, p < .0005$
	Intonation (No. Perfect Utterances)		
M	21.27	23.13	
s	5.19	5.76	$t = 2.68, p < .01$

Two possible interpretations of this finding are suggested. The first is that orthography facilitates pronunciation when there is a congruent phonetic fit between the spoken and written language. The second interpretation is that pronunciation shock may be a function of incompleted learning, a condition

which is probably present in any classroom where some students have completed more learning than others. The hypothesis here would be that if group learning in a classroom setting has more incompleted learning than individual learning in a laboratory situation, then pronunciation shock would be expected in the former but not the latter.

Individual differences in pronunciation.—The data in Table 19 indicate that skill in pronunciation was significantly correlated with learning and retention. Pronunciation did not correlate with the Modern Language Aptitude nor the Otis scores, except when pronunciation was measured in the number of phonemic errors. Probably the expanded range for the error score accounts for the difference.

TABLE 19

JAPANESE II: INDIVIDUAL DIFFERENCES IN PRONUNCIATION ($df = 13$)

	PA (1)	PE (1)	I (1)	PA (2)	PE (2)	I (2)
Initial Learning (Lists 4, 5, 7, and 8)						
Acquisition Error	−.55*	.52*	−.60**	−.46*	.17	−.58*
Immediate Recall	−.62**	.77†	−.82†	−.52*	.36	−.63**
Relearning						
Acquisition Error	−.17	.57*	−.36	−.29	.52*	−.26
Immediate Recall	−.54*	.73†	−.60**	−.54*	.50*	−.51*
Delayed Recall (Lists 4, 5)	.64†	−.66†	.58*	.84†	.47*	.83†
MLAT	.22	−.62**	.21	.41	−.48*	.41
OTIS	.15	−.33	.15	.27	−.52*	.38

Key.—PA refers to the number of Japanese utterances which were phonemically accurate, PE refers to the number of phonemes within Japanese utterances which were in error, I refers to the number of Japanese utterances which had acceptable intonation. The numerals in parenthesis, i.e., PA (1), PA (2) . . ., refer to either the first retention test after oral learning or the second retention test after visual relearning.
*$p = .05$. **$p = .01$. †$p = .005$.

Also, it is interesting that individual differences in pronunciation between *Ss* tended to be quite stable no matter what training they experienced. The evidence for this is that pronunciation on the retention test after initial oral learning correlated with pronunciation on the retention test after visual relearning as follows: .77 ($p < .005$) for phonemic accuracy scores and .66 ($p < .005$) for intonation scores.

RUSSIAN EXP. I[8]

The Spanish and Japanese studies were quite similar for the relationship

[8]The preparation of Russian materials and the scoring of tapes were accomplished by Drs. Eugene Eiche and Taras Lukach of San Jose State College, and Dr. Peter Lackowski of the University of Washington. The graduate assistants were Arthur C. Vicory, Miles A. Vich, and Allan D. Pratt. For many valuable suggestions as to changes in the manuscript, appreciation is expressed to Dr. John C. McCullers, and to Dr. Richard I. Post for his statistical assistance.

of vision and audition in the transfer of learning. This similarity of results may be a function of the phonetic fit in Spanish and Japanese between the spoken and written language. Since there is something of a *"phonetic misfit"* in Russian between the spoken language and the orthography, the expectation was that the results of an intersensory transfer study with Russian should be deviant from the findings obtained with Spanish or Japanese. *"Phonetic misfit"* here means that there is not a one-to-one correspondence between phonemes and the visual notation. English would be another language which may be classified as a phonetic misfit because some 40 allophones in English may be spelled in 2,000 different ways.

Procedure

Subjects.—Forty undergraduate students with no history of prior training or exposure to Russian were randomly assigned as visual or aural *Ss*. Each group had 10 males and 10 females. These *Ss* were paid volunteers recruited from classes in general psychology.

Predictors.—The five predictors used in Japanese I were also applied in this study. These were the *Modern Language Aptitude Test*, the *Otis Mental Ability Test*, the guessing measure, the visual test (List 1) and the oral test (List 2). Administration was identical except that Russian instead of Japanese was the response content for the guessing measure, List 1, and List 2.

Vocabulary learning.—The first two exposures of an item were training trials in which visual *Ss* ($N = 20$) viewed an English word for 1 sec., followed by a Russian word for 2 sec. The inter-item interval was about 3 sec. On each trial after the second training trial, the visual *S* saw the English stimulus for 1 sec., then had 7 sec. to write the Russian, and finally viewed the correct Russian for 2 sec. The inter-item interval was about 12 sec. during which *E* scored *S*'s response as "correct" or "incorrect."

As in the prior studies, items were presented randomly on each trial and each item was discarded from the list as *S* responded correctly on two successive trials. After the criterion was achieved, there was a retention test, followed by the translation of two sentences in Russian. Then a 5-min. rest occurred before *S* relearned the list by audition.

Aural *Ss* reversed the procedure by learning first through audition then relearning by vision. The details of administration were identical with Japanese I except that an additional auditory retention test was given to aural *Ss* after they completed visual relearning. The purpose of this was to assess the presence or absence of pronunciation shock following the introduction of Russian orthography.

In the first meeting between an *S* and *E*, the following were administered: The guessing measure, List 1, and List 2. In the second meeting 48 hr. later, *S*

learned Lists 4 and 5, and 48 hr. after the second session, in the third meeting, *S* learned Lists 7 and 8 followed by a retention test for all 60 items learned.

Materials and apparatus.—Both were the same as those in Spanish I.

Results

Vocabulary learning.—The *t* tests in Table 20 indicate that in the acquisition of Lists 4, 5, and 7, there was negative transfer of learning between vision and audition which was, however, *not* significant at the .05 level. Since skewness was extreme, the median test was applied and the results coincided with the *t* test.

The transfer from audition to vision was positive, but significant only for the *t* test ($p < .025$), not the median test ($p < .20$).

These findings tended to be supported by data from Fallentine (1961) and Clock (1962) who used a 10-item list of English to Russian paired-associate items with the Method of Adjusted Learning. With the median test, they found negative transfer from vision to audition and positive transfer from audition to vision, but the χ^2's of .80 for each condition were not significant at even the .10 level.

As in the studies with Spanish and Japanese, an attempt was made to evaluate the factor of differential input for vision vs audition. A visual display tends to be transmitted simultaneously to *S*, while the auditory stimulus is received sequentially. The visual presentation of List 8 was displayed sequentially as was described in Footnote 6.

The results, again referring to Table 20, showed negative transfer from vision to audition which was of marginal significance ($p = .10$) and positive transfer from audition to vision which was *not* significant at even the .10 level.

Generally, the results for Russian seemed to demonstrate negative transfer from vision to audition and positive transfer from audition to vision, but the transfer effects were not strong enough to register as statistically significant at the .05 level.

Sensory sequence effects.—The first analysis was based on composite errors in which the errors in initial learning and relearning were summed for each *S*. For a discussion of the rationale behind this, see Japanese I. The results were a mean composite error of 318.87 for visual *S*s and 273.75 for aural *S*s. The mean difference in favor of the audition-vision sequence yielded a *t* of 1.22 which was not significant.

The second analysis in Table 21 shows that after a 48-hr. delay between learning and the retention test, the sequence of audition-vision produced a significantly better quality of pronunciation than vision-audition as measured in both phonemic accuracy scores ($t = 2.98$, $p < .005$) and intonation scores ($t = 3.46$, $p < .0005$). The superiority of audition-vision in comparison with vision-audition was further supported with a median test for items recalled after a 48-

TABLE 20

RUSSIAN I: ACQUISITION ERROR IN LEARNING

Transfer from Vision to Audition	Initial *Auditory* Learning by Aural *Ss*			*Auditory* Relearning by Visual *Ss*			% Saving for		t	χ^2
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*	*Ms*	*Mdns*		
Lists 4, 5, 7	86.75	67.50	62.61	90.45	74.50	42.56	−04	−10	.20§	0.00§
List 8	34.60	25.50	23.93	44.95	41.50	25.04	−30	−63	1.33†	3.60†
Transfer from Audition to Vision	**Initial *Visual* Learning by Visual *Ss***			***Visual* Relearning by Aural *Ss***						
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*				
Lists 4, 5, 7	107.45	105.50	36.59	85.50	87.00	27.28	20	18	2.15*	2.51‡
List 8	75.90	76.00	29.50	66.90	63.50	29.43	12	16	0.96§	0.90§

*$p = .02$. †$p = .10$. ‡$p = .20$. §Not significant, NS.

TABLE 21

RUSSIAN I: RETENTION MEASURED IN CORRECT RECALL

		Visual *Ss* ($N = 20$)		Aural *Ss* ($N = 20$)		t	p
		M	*SD*	*M*	*SD*		
	Pronunciation Scores for the Second Retention Test						
Lists 4, 5, 7	PA (2)	14.85	4.45	14.90	3.14	0.00	NS
	I (2)	21.20	2.66	22.10	3.17	.97	NS
List 8	PA (2)	4.20	1.57	3.30	1.65	1.76	.05
	I (2)	7.10	1.68	7.15	2.23	0.00	NS
	Pronunciation Scores for 48-Hr. Delay						
Lists 4, 5	PA (2)	4.05	2.09	6.05	2.08	2.98	.005
	I (2)	4.89	2.10	7.45	2.48	3.46	.0005

hr. delay between learning and retention. The result was a significant χ^2 of 8.12 ($df = 1, p < .01$).

Pronunciation shock.—The three measures for the quality of pronunciation demonstrated pronunciation shock. In Table 22, the t tests were highly significant, suggesting that if Russian orthography is introduced immediately after intensive oral training, the effect is to decrease the quality of pronunciation.

TABLE 22

RUSSIAN I: PRONUNCIATION SHOCK: AURAL *Ss*

	Pronunciation Scores After Oral Learning	Pronunciation Scores After Orthography was Introducted	
	Phonemic Accuracy (No. Perfect Utterances)		
M	20.80	18.25	
s	5.09	4.10	$t = 2.58, p < .01$
	Intonation (No. Perfect Utterances)		
M	31.40	29.30	
s	3.99	4.68	$t = 2.97, p < .005$
	Phonemic Error (No. Errors within Utterances)		
M	44.05	51.20	
s	23.60	27.70	$t = -2.98, p < .005$

A further analysis showed that pronunciation shock was associated with "difficult" rather than "easy" Russian items. "Difficult" and "easy" items were operationally defined by ranking the 40 items from Lists 4, 5, 7, and 8 according to the total number of acquisition errors for all aural *Ss*. The item with the least error was ranked as *1* and the item with the most error was ranked as *40*. Items above the median were defined as "easy" items and those below the median as "difficult" items.

Pronunciation shock was operationally defined as a significant *decrease* in phonemic accuracy (PA) or acceptable intonation (I), and a significant *increase* in the number of phonemic errors (PE) after orthography was introduced to aural *Ss*. *For easy items*, the *t* tests for correlated samples were as follows: (a) 1.95 (NS) for PA, (b) −.63 (NS) for I, and (c) .74 (NS) for PE. Since none of the *t*s for the easy items were significant at the .05 level, the inference is that pronunciation shock was *not* associated with easy Russian items.

For difficult items, the *t* tests for correlated samples were: (a) 6.47 ($p < .0005$) for PA, (b) 3.52 ($p < .005$) for I, and (c) −2.79 ($p < .01$) for PE. Since all of the *t* tests for difficult items were highly significant, the implication is that pronunciation shock was associated with Russian items that are difficult to learn.

Reliability of the pronunciation measures.—The three pronunciation measures were (1) the number of items with no phonemic errors (PA), (2) the number of items which the expert decided had acceptable intonation (I), and (3) the number of phonemic errors (PE). The reliability of these was obtained in a score-rescore procedure with about 9 mo. intervening between the first and second scoring by the expert in Russian.

For the rescoring, four *Ss*, 2 males and 2 females, were selected at random. A male and female were drawn from each group of visual and aural *Ss*. Then the expert, with no information as to what his judgments were in the first scoring, listened again to the tapes and rescored. The results in Table 23 yielded acceptable reliability coefficients.

TABLE 23
RUSSIAN I: RELIABILITY OF THE PRONUNCIATION MEASURES

Recall		Visual *Ss*	Aural *Ss*
Immediate (1)	PA		.51
	I		.93
	PE		.92
Immediate (2)	PA	.88	.94
	I	.91	.91
	PE	.97	.97
Delayed	PA	.80	.90
	I	.83	.97
	PE	.97	.99

Key.—PA = The number of items phonemically accurate, I = The number of items with acceptable intonation, PE = The number of phonemes in error.

Homogeneity of Ss.—There were no significant differences at the .05 level between visual and aural *Ss* on any of the five predictor measures.

Validity of the predictors.—As in Japanese I, the highest validity coefficients in Table 24 were associated with the visual and oral tests. The next

TABLE 24

RUSSIAN I: VALIDITY COEFFICIENTS FOR THE VISUAL AND ORAL TESTS

Criterion Measures	Visual Ss ($N = 20$)			Aural Ss ($N = 20$)		
	Visual Test (List 1)	Oral Test (List 2)	Composite (Lists 1 + 2)	Visual Test (List 1)	Oral Test (List 2)	Composite (Lists 1 + 2)
Acquisition Errors for Lists 4, 5, 7, 8	.65	.32	.60	.66	.88	.83
Immediate Recall for Lists 4, 5, 7, 8	.42	.20	.37	.56	.49	.51
48-Hr. Delayed Recall for Lists 4 and 5	−.29	−.14	−.23	.56	−.38	−.48
Pronunciation for Immediate Recall of Lists 4, 5, 7, 8						
After Initial Learning						
PA				−.25	−.15	−.16
I				−.24	−.20	−.16
PE				.39	.26	.34
After Relearning						
PA	−.44	−.39	−.54	−.37	−.33	−.28
I	−.42	−.32	−.34	−.51	−.56	−.52
PE	.41	.38	.47	.42	.33	.46
Sentences (After Initial Learning)						
No. Words Correct	−.24	−.40	−.24	−.44	−.46	−.57
No. Sentences Correct	−.22	−.12	−.22	−.44	−.44	−.68

Key.—PA = The number of items phonemically accurate, I = The number of items with acceptable intonation, PE = The number of phonemes in error.
Note.—For 18 *df*, $r = .38$ at p .05, $r = .52$ at p .01, and $r = .56$ at p .005.

TABLE 25

RUSSIAN I: VALIDITY COEFFICIENTS FOR THE MODERN LANGUAGE APTITUDE TEST (MLAT) AND THE OTIS MENTAL ABILITY TEST

Criterion Measures§	Visual Ss ($N=20$)		Aural Ss ($N=20$)	
	MLAT	OTIS	MLAT	OTIS
Acquisition Error	−.30	−.12	−.34	−.24
Immediate Recall	.48*	.27	.53†	−.33
48-Hr. Delay in Recall	.21	−.09	.38*	.28
Pronunciation After Initial Learning				
Phonemic Accuracy			.60‡	.54†
Intonation			.43*	.34
Phonemic Error			−.46*	−.45*
After Relearning				
Phonemic Accuracy	.62‡	.39*	.78‡	.71‡
Intonation	.15	−.07	.58†	.50*
Phonemic Error	−.42*	−.07	−.56‡	−.60‡
Sentences (After Initial Learning)				
No. Words Correct	.49	−.12	.53	.67
No. Meanings Correct	.48	−.08	.52	.67

§All criterion scores are for Lists 4, 5, 7, and 8, except delayed recall which was scored for Lists 4 and 5.
Note.—For 18 *df*, $r = .38$ at p .05*, $r = .52$ at p .01†, $r = .56$ at p .005‡

TABLE 26

RUSSIAN I: VALIDITY COEFFICIENTS FOR GUESSING MEASURE

Criterion Measures§	Visual Ss ($N=20$)			Aural Ss ($N=20$)		
	G_1	G_2	G_3	G_1	G_2	G_3
Acquisition Errors	.22	−.33	−.33	−.01	.30	.24
Immediate Recall	.35	.55*	.52†	−.31	−.20	−.34
48-Hr. Delay in Recall	.08	−.11	−.02	−.15	−.30	−.36
Pronunciation						
After Initial Learning						
Phonemic Accuracy				−.04	−.08	−.09
Intonation				−.10	−.23	−.25
Phonemic Error				.16	−.00	.13
After Relearning						
Phonemic Accuracy	.28	.00	.17	.06	−.31	−.22
Intonation	.38*	.06	.26	−.18	−.58‡	−.58‡
Phonemic Error	−.15	.12	−.01	.06	.01	.06
Sentences (After Initial Learning)						
No. Words Correct	.29	−.09	.12	−.10	−.20	−.24
No. Meanings Correct	.18	−.19	−.01	−.08	−.07	−.12

§All criterion scores are for Lists 4, 5, 7, and 8 except delayed recall which was scored for Lists 4 and 5.
Note.—For 18 *df*, $r = .38$ at p .05*, $r = .52$ at p .01†, $r = .56$ at p .005‡.
Key.—G_1 = Guessing score for items learned, G_2 = Guessing score for items not learned, $G_3 = G_1 + G_2$.

TABLE 27

RUSSIAN I: RELIABILITY OF THE CRITERION MEASURES

Criterion Measures	Visual Ss (N=20)	Aural Ss (N=20)
Acquisition Error	.86†	.95†
Immediate Recall	.62†	.28
48-Hr. Delay in Recall	.75†	.53**
Pronunciation After Initial Learning		
Phonemic Accuracy		.63†
Intonation		.48*
Phonemic Error		.67†
Pronunciation After Relearning		
Phonemic Accuracy	.76†	.50*
Intonation	.29	.68†
Phonemic Error	.87†	.86†
Sentences (After Initial Learning)		
No. Words Correct	.54**	.35
No. Words Correct	.53**	.33

Note.—All correlations involve Lists 4 and 5 vs 7 and 8 except delayed recall which is List 4 vs List 5. All coefficients have been adjusted with the Spearman-Brown formula for split-halves.
For 18 *df*, r = .38 at p .05*, r = .52 at p .01**, r = .56 at p .005†.

highest set of validities in Table 25 were identified with the *Modern Language Aptitude Test* and the *Otis Mental Ability Test*. Finally, the guessing measure in Table 26 yielded almost zero order correlations for most of the coefficients.

Reliability of the criterion measures.—The reliability coefficients for the Russian criterion measures were determined with a split-half procedure in which Lists 4 and 5 were correlated with Lists 7 and 8. The results in Table 27 were reliabilities which were lower than those obtained for Japanese in Table 16. Also the coefficients obtained for Russian pronunciation scores were lower using the split-half technique in comparison with the score-rescore method.

Intercorrelations between predictors.—These correlations can be examined

TABLE 28

RUSSIAN I: INTERCORRELATIONS BETWEEN PREDICTORS FOR VISUAL Ss (N = 20)

	VT	OT	C	MLAT	OTIS	G_1	G_2	G_3
VT		.30	.82	−.25	−.51	.02	.44	.27
OT	.30		.68	−.34	−.34	.01	.17	.11
C	.82	.68		−.40	−.55	.00	.46	.28
MLAT	−.25	−.34	−.40		.49	.04	−.36	−.20
OTIS	−.51	−.34	−.55	.49		−.18	−.35	−.31
G_1	.02	.01	.00	.04	−.18		.40	.83
G_2	.44	.17	.46	−.36	−.35	.40		.84
G_3	.27	.11	.28	−.20	−.31	.83	.84	

Key.—VT = Visual test, OT = Oral test, C = VT + OT, MLAT = Modern Language Aptitude Test, OTIS = Otis Test of Mental Ability, G_1 = Guessing score for items later learned, G_2 = Guessing score for items not learned, G_3 = G_1 + G_2.

TABLE 29

RUSSIAN I: INTERCORRELATIONS BETWEEN PREDICTORS FOR AURAL *Ss* ($N = 20$)

	VT	OT	C	MLAT	OTIS	G_1	G_2	G_3
VT		.66	.82	−.30	−.34	.08	.25	.25
OT	.66		.92	−.18	−.23	−.12	.39	.25
C	.82	.92		−.17	−.27	.04	.31	.28
MLAT	−.30	−.18	−.17		.78	−.22	−.34	−.40
OTIS	−.34	−.23	−.27	.78		−.10	−.29	−.29
G_1	.08	−.12	.04	−.22	−.10		.01	.56
G_2	.25	.39	.31	−.34	−.29	.01		.83
G_3	.25	.25	.28	−.40	−.29	.56	.83	

Key.—See Table 29.

in Tables 28 and 29. The intercorrelations were much lower than those obtained in Japanese I.

TURKISH AND PERSIAN

Unpublished data from Fallentine (1961) and Clock (1962) furnish information about sensory relationships in the learning of Turkish and Persian. Fallentine had *Ss* ($N = 10$) learn a 10-item paired-associate list of English to Japanese items. *Ss* first learned the items visually, then relearned aurally with the method of adjusted learning. Then these *Ss* learned another 10-item set in Russian, another in Turkish, and finally a set in Persian. Clock reversed the sensory order by having other *Ss* ($N = 10$) first learn the same items by audition and then relearn by vision.

In considering these data one should be aware of a possible confounding factor in that one *E* collected data for the visual *Ss* and the other *E* collected data for the auditory *Ss*. This confounding is an artifact of an attempt by the writer to relate data from two studies, one by Fallentine and the other by Clock, which were designed for purposes other than the sensory problem explored in this paper.

Results

Turkish.—Since Turkish has an excellent phonetic fit between the orthography and spoken language, the expectation was that the results would be similar to the findings for Spanish or Japanese. This expectation was confirmed when a median test was applied. As seen in Table 30, the transfer from vision to audition was positive and yielded a significant χ^2 of 20 ($p < .001$, $df = 1$). However, there was *neutral transfer* from audition to vision with a χ^2 of zero.

Persian.—Since the orthography of Persian is in a transcription which is completely unfamiliar to the English speaker, a prediction was difficult on the basis of a *phonetic fit hypothesis.*

In Table 30, Condition A′ represents the learning sequence of Japanese,

TABLE 30

TURKISH AND PERSIAN: ACQUISITION ERROR IN LEARNING

Transfer from Vision to Audition	Initial *Auditory* Learning by Aural Ss			*Auditory* Relearning by Visual Ss			% Saving for		χ^2
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*	*M*	*Mdn*	
Turkish A'	48.40	44.50	11.91	6.30	3.50	6.68	87	92	20.00*
Persian A'	35.10	33.00	12.76	22.40	22.00	6.10	36	33	3.20
Persian B'	38.50	38.50	10.62	22.20	20.00	10.16	42	48	7.20
Transfer from Audition to Vision	**Initial *Visual* Learning by Visual Ss**			***Visual* Relearning by Aural Ss**					
	M	*Mdn*	*SD*	*M*	*Mdn*	*SD*			
Turkish A'	26.90	27.50	7.23	27.80	24.50	15.87	-03	11	0.00
Persian A'	40.70	39.00	10.28	69.40	70.00	13.99	-70	-80	12.80*
Persian B'	28.30	26.50	9.60	78.80	83.00	20.35	-178	-213	20.00*

*$p \leq .01$.

Russian, Turkish, and then Persian; while Condition B′ is the sequence of Japanese, Russian, and finally Persian.

The results from vision to audition, again with a median test, suggested positive transfer for A′ with a χ^2 of 3.20 ($p < .10$) and for B′ with a χ^2 of 7.20 ($p < .01$). However, there was negative transfer from audition to vision, with A′ having a χ^2 of 12.80 ($p < .001, df = 1$) and B′ showing a χ^2 of 20.00 ($p < .001, df = 1$).

Summary of Data: All Languages

Vocabulary Learning

The transfer of learning from visual to aural learning was positive and statistically significant for Spanish, Japanese, Turkish, and Persian. However, the transfer for Russian was negative but not of enough magnitude for statistical significance. The savings scores may be examined in Table 31.

TABLE 31

Per Cent Savings in Transfer for Means and Medians for Each Language

Lists		Vision to Audition		Audition to Vision	
		Ms	*Mdns*	*Ms*	*Mdns*
Spanish I	3, 4, 5, 6, 7	77	86	46	57
	8	80	83	50	50
Spanish II	9	93	100	89	83
	10	89	95	72	68
Spanish III	4, 5, 6, 7	82	80	30	34
	8	94	100	45	43
Japanese I	4, 5, 7	84	84	25	46
	8	85	95	50	58
Russian I	4, 5, 7	−04	−10	20	18
	8	−30	−63	12	16

There was positive transfer from aural to visual learning which was definitely significant for Spanish but only marginally significant for Japanese and Russian. This transfer seemed to be neutral for Turkish and negative for Persian ($p = .001$).

Sensory Sequence Effects

Composite errors.—The sequence of vision-audition in learning was superior to audition-vision for Spanish I, II, III, and Japanese. For Russian the trend favored audition-vision, but this was not statistically significant at even the .10 level.

Retention.—For Spanish I, neither sensory order produced superior recall on a test taken immediately after learning or on recall tests 48 to 96 hr. later. However, when retention was measured as recognition, the results were highly significant ($p = .005$) in favor of the sequence vision-audition. In Spanish II, one of the two picture vocabulary lists yielded a significant difference ($p = .05$) in recall after 1 mo. which favored the vision-audition sequence, but in Spanish III, neither a recall test immediately after learning nor one given 48 hr. later showed a significant difference between sensory orders.

With Japanese I the immediate recall test showed retention and pronunciation to be superior for the vision-audition sequence, but the difference was not statistically significant after a 48-hr. interval between learning and retention.

For Russian I there was no significant difference in the immediate retention test for recall and pronunciation between sensory sequences, but after a 48-hr. interval between learning and the recall test, there was a significant difference favoring the audition-vision sequence.

Pronunciation shock.—After intensive oral training in Japanese, there was no pronunciation shock when orthography (the *Romaji*) was introduced. Rather, the introduction of written Japanese in the Romanized alphabet facilitated the quality of pronunciation. However, after intensive oral training in Russian, the exposure to orthography generated pronunciation shock as measured in a significant decrease in the quality of spoken Russian.

Validity of the predictors.—For Japanese and Russian the visual and oral work-sample tests yielded the highest validity coefficients; next were the *Modern Language Aptitude Test* and the *Otis Mental Ability Test*. Finally, the guessing measures showed almost zero-order validity coefficients.

In Spanish I and III, the visual and oral work-sample tests showed higher validity coefficients for the performance of aural Ss. In Spanish II, where the stimulus was a picture and the response was made in Spanish, the work-sample tests correlated highly with the learning of visual or aural Ss. In all three of the Spanish studies the guessing measure yielded high validity coefficients with the criterion measures, but in Spanish II and III the higher coefficients were associated with aural Ss.

A Note of Caution

Psychological experiments in verbal learning with either nonsense syllables or natural languages have usually been evaluated by linguists as *non-representative of language learning because of excessive simplification* (Carroll, 1963). In the data presented in this paper, for example, the reductionism of natural languages to one-word units, while achieving better experimental control, may have eliminated complexities which are the essence of language learning such as phonology, morphology, and syntax. It may be that this reductionism produces a learning task which has little in common with language learning. If so, then inferences based on such data certainly should only be considered as suggestive rather than definitive.

Recently, Vicory (1963) completed a study at the Defense Language Institute (West Coast Branch) which offers some evidence related to this issue. Vicory wanted to discover how closely the simplified, one-word unit paired-associate learning task was related to complex foreign language learning. To explore this problem, he administered predictor measures to language students, before they began an intensive 8-hr.-a-day study five days a week for 11 mo. in either Polish, Hungarian, or Bulgarian. The main predictor was a paired-associate (P-A) task of 10 English to Polish words learned visually and 10 English to Polish words learned by listening and speaking the Polish. Each P-A task required an hour. Other predictors included general mental ability tests and the *Modern Language Aptitude Test*.

The results were that none of the predictors correlated highly with Bulgarian or Hungarian, but for the Polish, the English to Polish paired-associate task learned aurally, correlated almost perfectly with ratings of fluency taken after 1, 2, and 6 mo. of language training.

The implication here is that the reductionism of the paired-associate task still preserves a representative relationship with the complex learning of a specific language if

the response units of the P-A task are drawn from the population of utterances for a particular natural language. This inference must still be considered speculative until further work not only cross-validates Vicory's finding with Polish, but demonstrates that the connection between the P-A task and complex language learning holds for many different natural languages.

Discussion

The Phonetic Fit Hypothesis

The data presented in this paper seem to support the notion that a sense receptor as vision or audition operates in learning as a function of the information being received or transmitted. For example, when there is a one-to-one correspondence between the sound and the visual character, the transfer in either direction between vision and audition is positive and of large magnitude. This generalization tends to support a *phonetic fit hypothesis*. The more congruent the relationship between allophones and the visual notation, the greater the probability of a large, positive transfer in learning. Another way of describing a congruent relationship would be to determine how well the phonology can be covered if one is given the orthography or in reverse, when learning to phonology how well can one transcribe into the orthography. Spanish, Japanese, and Turkish tend to have a phonetic fit between sound and visual notation, while English, Russian, and Persian tend to have a phonetic misfit or incongruent relationship.

Another implication of the phonetic fit hypothesis is that the application of phonetic or phonemic transcription should facilitate the transfer from speaking to reading or reading to speaking.

The Central Mediation Hypothesis

If the information being transmitted or received is the critical determinant of the nature and amount of transfer, then data may be interpreted as support for a central locus for the mediation of sensory process. Such an hypothesis suggests that the sensory channel merely relays data to or out of a data-processing location in the brain. A peripheral hypothesis, by contrast, implies that the sensory receptor including the connecting neural network has a data-processing function. An illustration of the peripheral notion may be Broadbent's model (1958) which conceptualizes a mechanism, located close to the auditory receptor, that selects messages to be sent to the brain. The selection may be a function of simple qualities within the signal as frequency or intensity.

One implication of the central mediation hypothesis is that patterning of the stimulus becomes important. Only linguists seem to have recognized the significance of stimulus patterning in such concepts as the phoneme and the morpheme (Carroll, 1953, 1963; Gleason, 1961; Lado, 1961; Hockett, 1962). Perhaps the one factor which has blocked psychological research into the problem

of stimulus patterning was the invention of the nonsense syllable (Asher, in press).

Phonetic Symbolism

The finding of significant correlations between S's guesses (as to the possible meaning of an unfamiliar Spanish utterance) and the later learning of the Spanish vocabulary items suggested some support for the notion of phonetic symbolism (Taylor, 1963). However, the zero-order correlations between guessing and language learning for both Japanese and Russian tended to cancel confidence in an hypothesis of phonetic symbolism. The most probable interpretation of the success in guessing the Spanish was transfer from other Romance languages with which Ss were familiar.

Primacy of Spoken Language

When there was a phonetic fit between the spoken and written language, there usually was large, positive transfer in either sensory direction, but transfer from vision to audition tended to be significantly greater in comparison with the transfer from audition to vision. This suggests that, when the language has a phonetic fit, there is an interaction between sensory channel and the data being transmitted or received, and the interaction favors the visual modality.

If so, then why the primacy of spoken language for children? Why, for example, do children learn a spoken language first before they learn to read and write? Is there something inherent in the auditory receptor, perhaps as a function of imprinting (Hess, 1958) or the brain physiology of children (Penfield & Roberts, 1959), which facilitates the superiority of audition?

The *signal to receptor hypothesis* suggests that the neural mechanism of vision or audition is probably not the explanation for the primacy of spoken language. Rather, the relationship of the input signal to the sense receptor is a more reasonable hypothesis. To illustrate this, consider that an auditory signal or speech can be transmitted to the child's ear even if the child (a) is facing away from the signal source, (b) is in motion, (c) is exhibiting any posture around the signal's source, including the area directly behind, and (d) has a nonlinear alignment between the auditory signal and the sense receptor. Therefore, *the relationship of the auditory stimulus to the sense receptor is wide-band receptivity* in comparison with the *narrow-band* of the visual signal to its receptor.

The narrow-band relationship between the visual signal, as a printed message, and the eye is indicated by the observation that to receive the visual signal, one must (a) be facing the signal, (b) probably be stationary, (c) be located in an area in front of the signal's source, and (d) have a linear alignment between the visual signal and the sense receptor.

Since small children are "perpetual motion machines," only the wide-band

sensitivity of the receptor to the auditory signal permits the occurrence of basic learning operations as contiguity, feedback, and reinforcement.[9]

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[9]It has been suggested that an important factor favoring early symbolic learning through audition rather than vision is that children's motor development required for writing occurs after speech. This hypothesis is less persuasive when one considers that reading may be learned independently of writing just as one may learn listening fluency in a new language quite independently from the acquisition of speaking (Penfield, 1959; Asher, in press). Perhaps developmental studies of the congenitally deaf and blind will give new insights into the intricate relationship of sensory process to symbolic learning. Especially interesting would be developmental studies of sign language learning by congenitally deaf children or normal children of deaf parents.

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APPENDIX

ENGLISH STIMULUS WORDS USED IN LISTS 1 THROUGH 8

List 1	List 4	List 7
1. THAT	1. OF	1. YOU
2. WAS	2. (THEY) HAVE	2. HE
3. FOR	3. BUT	3. JUST
4. WHAT	4. THINK	4. ON
5. PEOPLE	5. PERSON	5. (HE) SAYS
6. UP	6. (THE) THINGS	6. WHEN
7. SO	7. (THEY) CAN	7. GOOD
8. OTHER	8. MY	8. EXAMPLE
9. GOING	9. SOME	9. COULD (WOULD BE ABLE)
10. WANT	10. ALWAYS	10. (HAS) BEEN
List 2	**List 5**	**List 8**
1. TO (TOWARD)	1. AND	1. IT
2. THEY	2. IN	2. ARE
3. (HE) CAME	3. SHE	3. IF
4. ACT	4. HAD	4. KNOW (COMMAND)
5. WHO	5. (I) WANT	5. OUTSIDE
6. TIME	6. ME	6. THIS
7. SAY	7. GO	7. BY
8. ALL	8. SO	8. (HE) DID
9. QUITE	9. (A) COURSE	9. WAY
10. THEN	10. TWO	10. GREET

(continued next page)

ENGLISH STIMULUS WORDS USED IN LISTS 1 THROUGH 8 (CONT'D)

List 3	List 6
1. (HE) IS	1. I
2. NOT	2. DO
3. WE	3. WITH
4. AFTER	4. VERY
5. THEM	5. SOMETHING
6. (WE) MADE	6. AS
7. WERE	7. (TO) HIM (TO HER)
8. TEACHERS	8. (I) CANNOT
9. ONE	9. (I) AM
10. THAN	10. ANY

Note.—The complete set of words and sentences, including the Spanish, Japanese, and Russian translations may be obtained from ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D. C. Order Document No. 7982, remitting $2.50 for photocopies or $1.75 for 35-mm. microfilm.